

## **Cryptic larval polychromatism in *Rekoa marius* Lucas and *R. palegon* Cramer (Lycaenidae: Theclinae).**

Ricardo Ferreira Monteiro

Universidade Federal do Rio de Janeiro, Instituto de Biologia, Departamento de Ecologia, Lab. de Ecologia de Insetos, Caixa Postal 68020, CEP 21941 - Rio de Janeiro, BRASIL

**Abstract.** *Rekoa marius* and *R. palegon*, are widely distributed neotropical hairstreaks that show cryptic larval polychromatism which is food dependent. Larvae of *R. marius* showed a short-term color shift when reared from different colored flower buds. A great number of host plant species belonging to several families were recorded for both *R. marius* and *R. palegon* larvae. Biological aspects of the larvae are presented and the relationships between cryptic polychromatism and polyphagy are discussed.

### **Introduction**

The neotropical hairstreak species *Rekoa marius* Lucas and *R. palegon* Cramer (Lycaenidae: Theclinae) are widely ranged from southern Texas (USA) to Argentina, and are known in butterfly literature as *Thecla ericusa* and *T. palegon* (Robbins, 1991).

The genus *Rekoa* has recently been revised by Robbins (1991) who refers to *Rekoa marius* and *R. palegon* larvae as polyphagous species, citing records mainly on Leguminosae and Malpighiaceae for the former and Asteraceae for the latter.

Apparently crypsis is very common among lycaenid larvae (e.g., Maschwitz *et al.*, 1984, 1985; Ballmer and Pratt, 1989), but records of larval cryptic polychromatism are poorly documented. For example, food-determined color pattern was reported in *Callophrys mossii bayensis* larvae (Brown, 1969), but was disputed by Emmel and Ferris (1972), and Orsak and Whitman (1986).

Malicky (1970) described Newcomer organs and perforated cupolas in *R. palegon* larvae, and most Theclinae are known to be ant associated (Hinton, 1951; Atsatt, 1981; Henning, 1983; Cottrell, 1984). However, no ants have ever been recorded for the two species studied here.

The purpose of this paper is to show the cryptic coloration in two *Rekoa* larvae species and discuss their food-dependent color mechanism in relation to polyphagy.

### **Materials and Methods**

From June 1985 to June 1989 I examined flower buds of about a hundred plant species in Barra de Maricá (22° 57'S, 42° 52'W) State of Rio de Janeiro, Brasil, consisting of beach sand dune vegetation ("restinga"), and covering an area approximately 200 ha.

Immatures of *Rekoa* species were collected, and larvae were reared in transparent plastic boxes, with moist paper on the bottom. Adult voucher specimens were deposited in Museu Nacional do Rio de Janeiro (Rio de Janeiro, Brasil) and in the National Museum of Natural History (Washington, DC).

To verify the effect of host plant on larval color, I collected 30 larvae of *R. marius* in the first and second instar, and five larvae in the third and fourth instar and reared them on different host species with four different flower bud colors. Five second instar larvae of *R. palegon* were also submitted to the same experiment. All larvae were observed daily.

The presence of attendant ants and the occurrence of parasitoids were also recorded.

## Results

### LIFE HISTORY AND CRYPTIC COLORATION

Immatures of *R. marius* are most common in summer and fall, but eggs and larvae may be found during most of the year. Larval development takes 22 days with four instars and pupal duration of 10 days ( $26.5^{\circ}\text{C} \pm 2$ ;  $65\% \pm 10$  RH;  $N=10$ ).

*R. marius* was found feeding on 30 host species of 26 genera belonging to 10 dicot families (Table 1). The main host plant species had Extra Floral Nectaries (EFN) on flower buds (*Arrabidaea conjugata* and *Lundia cordata*), leaves (*Senna bicapsularis* and *S. australis*) or bracts (*Ouratea cuspidata*). In these plant species ants were observed frequently visiting their EFN.

After eclosion larvae are yellowish and feed on small flower buds; as they grow they feed on larger flower buds and become cryptic. Although several host species were used, *R. marius* larvae always resemble the color of the flower bud on which they are fed (Fig. 1, A–F). Hence, in some host plants, such as *O. cuspidata*, *S. bicapsularis*, *Coccoloba arborescens* and *Lundia cordata*, young larvae of *R. marius* are green or whitish-yellow, corresponding to the color of the calyx of these plant species. The third and fourth instar larvae are predominantly yellow on the first two plant species, white on *C. arborescens* and red on *L. cordata*. Both young and mature larvae feeding on *Arrabidaea conjugata* were always lilac colored. This plant species, in contrast to the others, has a lilac calyx and corolla. The adults show no color variation correlating to larval host plant species.

*R. palegon* occurred in the study area mainly in fall and winter, when most of its host plant species, almost all Asteraceae, (Table 1) bloom. Larval development takes 23 days and pupa duration is 10 days ( $N=10$ ). The larvae are yellowish when they hatch. During the three following instars they become predominantly green, white, yellow or wine (Fig. 1, G–L). Larvae from inflorescences of *Mikania stipulacea* present two cryptic coloration patterns, wine-green when feeding on younger flower heads or green-white on mature flower heads.

Table 1. Host records of *Rekoa marius* and *R. palegon* larvae collected since 1985, from "restinga" of Barra de Maricá, Maricá, Brazil.

<i>Rekoa marius</i>	<i>Rekoa palegon</i>
<b>Apocynaceae</b>	<b>Asteraceae</b>
<i>Aspidosperma pyricollum</i>	<i>Mikania hoehnei</i>
<b>Bignoniaceae</b>	<i>M. stipulacea</i>
<i>Arrabidaea agnus-castus</i>	<i>M. micrantha</i>
<i>A. conjugata</i>	<i>Eupatorium laxum</i>
<i>Lundia cordata</i>	<i>E. odoratum</i>
<i>Adenocalymma marginatum</i>	<i>Vernonia scorpioides</i>
<i>Anemopaegma venusta</i>	<i>V. geminata</i>
<i>Jacaranda jasmínoides</i>	<i>Wedelia paludosa</i>
<i>Tabebuia chrystoricha</i>	<i>Wulfia baccata</i>
<b>Boraginaceae</b>	<i>Baccharis punctulata</i>
<i>Cordia verbenaceae</i>	<i>Trixis antimenorrhoea</i>
<b>Leguminosae</b>	<b>Polygonaceae</b>
<i>Senna bicapsularis</i>	<i>Coccoloba arborescens</i>
<i>S. australis</i>	
<i>Caesalpinia bonduc</i>	
<i>Cratylia hypargyrea</i>	
<i>Andira legalis</i>	
<i>Diocleaviolacea</i>	
<i>Swartzia apelata</i>	
<b>Malpighiaceae</b>	
<i>Byrsonima sericea</i>	
<i>Peixotoa hispidula</i>	
<i>Stygmaphyllon paralias</i>	
<i>Heteropteris chrysophylla</i>	
<b>Melastomataceae</b>	
<i>Marcetia taxifolia</i>	
<i>Tibouchina aff. holosericea</i>	
<b>Myrtaceae</b>	
<i>Eugenia uniflora</i>	
<i>E. ovalifolia</i>	
<i>Neomitranthes obscura</i>	
<b>Ochnaceae</b>	
<i>Ouratea cuspidata</i>	
<b>Polygonaceae</b>	
<i>Coccoloba arborescens</i>	
<i>C. alnifolia</i>	
<b>Sapindaceae</b>	
<i>Paullinia weinmanniaefolia</i>	

## FEEDING BEHAVIOR

Larvae of both species feed all day. They bore into the flower bud (or inflorescence) making a circular hole in which they insert their retractile heads and eat the reproductive tissue and part of the calyx and corolla.



Each *R. marius* larva ate about 40 to 50 flower buds of *O. cuspidata* or *S. bicapsularis* during its development. Food deprivation led to cannibalism; larger larvae generally ate smaller ones or pupae.

In the laboratory, *R. palegon* larvae reared on *S. bicapsularis* and *O. cuspidata* (*R. marius* host species) developed into adults in 90% of the cases (N=20). On the other hand 95% of *R. marius* larvae (N=20) failed to develop to pupae when reared in the three main host species used by *R. palegon*: *Mikania hoehnei*, *M. stipulacea* and *Vernonia scorpioides*.

#### NATURE OF COLORATION

Food plant shift experiments showed that first and second instar larvae change their coloration and become similar to the new host flower bud color. Twenty green or yellow first instar larvae of *R. marius* collected from *S. bicapsularis*, *S. australis* and *O. cuspidata* became lilac when reared on *A. conjugata* flower buds. Ten first and second instar lilac larvae from *A. conjugata* became yellowish after being reared with the three above host species.

Five green second instar larvae of *R. palegon* became yellowish when changed from *Eupatorium laxum* (green flower head) to *Wedelia paludosa* inflorescences (yellow flower head).

Coloration change occurs within three to five days after the food plant shift, but coloration becomes more pronounced after the first moult. Third and fourth instar larvae transferred to different colored host plants partially change their color and eventually showed intermediate colors.

#### PARASITISM AND MYRMECOPHILY

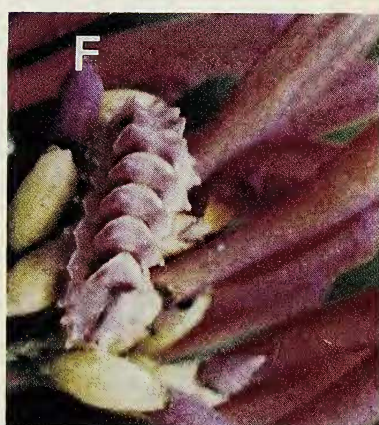
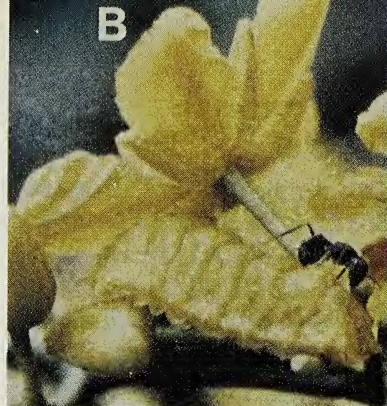
*Rekoa marius* and *R. palegon* larvae are hosts for the same four parasitoids: *Telenomus* sp. (Hym.: Proctotrupoidea: Scelionidae—egg), *Rogas* sp. (Hym.: Braconidae—larva), *Conura* n. sp. (Hym.: Chalcididae—larva/pupa) and a tachinid species (Diptera—larva/pupa). Total

---

Figure 1. *Rekoa marius* (A–F) and *R. palegon* (G–L) color patterns on some food plants.

- (A) *Ouratea cuspidata* (young flower bud)
- (B) *O. cuspidata* (mature flower bud)
- (C) *Coccoloba arborescens*
- (D) *Caesalpinia bonduc*
- (E) *Arrabidaea conjugata*
- (F) *Lundia cordata*
- (G) *Eupatorium laxum*
- (H) *Mikania hoehnei*
- (I) *M. stipulacea*
- (J) *Vernonia scorpioides*
- (K) *Wulfia baccata*
- (L) *Wedelia paludosa*







parasitism of each butterfly species in both years (1987-1988) was no more than 15% (N=300) for eggs and 5% (N=500) for larvae.

Several ant species were observed attending third and fourth instar larvae of *R. marius* (Fig. 1: B,C,E) (*Camponotus crassus*, *C. rufipes*, *C. cingulatus*, *Solenopsis* sp., and *Conomyrma* sp.) and *R. palegon* (*Camponotus crassus*, *Crematogaster* sp. and a dolichoderine species). The ants did antennation on the Newcomer gland and pore cupola but fed only from the former.

## Discussion

Color and feeding behavior of *R. marius* and *R. palegon* larvae provide them with camouflage (Fig. 1). Such cryptic host plant dependent polychromatism is caused by flavonoid and carotenoid pigments accumulated by larvae (Kaplan & Monteiro, unpublished data). Wilson (1987) showed that flavonoid content of several lycaenid species is dependent on the flavonoid content of larval food, and although she suggested that flavonoid pigments act as chemical defenses, I suspect that they confer crypsis rather than aposematism in *Rekoa* larvae.

Brower (1958) speculated on the selective advantage of polyphagy in cryptic insects, suggesting that populations using several host plant species would be more difficult for insectivorous birds to find. Color polymorphism would break the insect population into several "visual species" each of which would have to be learned independently by avian predators. In both *Rekoa* species, food plant induced coloration produced cryptic polychromatism, dividing the population into several "visual species." Such a mechanism may be of great importance because there would be no non-cryptic individuals. Hence, polyphagy would not be dependent on the number of cryptic color morphs, as in polymorphism, but quite the contrary, the number of morphs would be determined by the host plant coloration patterns. Polyphagy in these hairstreaks may also allow them to reproduce for longer periods in the year, overcoming the problems of ephemeral food resources in nature.

The wide range of host plants used by many thecline species, considered uncommon among other butterflies, may be due in part to their flower-feeding habit (Robbins & Aiello, 1982). However, I believe that the color determination mechanism found in *Rekoa* may also play an important role on host range width providing larval cryptic protection for whichever host plant used. Such a mechanism indicates that a perfect camouflage does not necessarily require a monophagous habit of larva, as has been suggested by Maschwitz *et al.* (1984, 1985).

Although for flower bud feeding and ant associated lycaenids the presence of Extra Floral Nectaries (EFN) in their host plants may be less important than in foliage feeding species, it is remarkable that the five main food plants of *R. marius* (*S. bicapsularis*, *S. australis*, *L. cordata*, *A. conjugata* and *O. cuspidata*) bear EFN. As these larvae do not feed on EFN, in contrast to what was observed in a riordinid species by De Vries

and Baker (1989), it is possible that this host species preference is based on a direct correlation between a higher frequency of ants in the host plants and the rate of larvae survival as verified in other lycaenid species (Atsatt, 1981; Henning, 1983; Pierce & Elgar, 1985).

Ant protection against parasitoids recorded for some lycaenids (Pierce & Mead, 1981; Atsatt, 1981; Pierce & Easteal, 1986) may also occur in *Rekoa* as indicated by the low parasitism rate found in both myrmecophilous species.

**Acknowledgements.** Margarete V. Macêdo helped me in all phases of this work. Rogério P. Martins, Curtis Callaghan, Donald Harvey and Robert K. Robbins and two anonymous reviewers gave valuable critical comments on the manuscript. Robert Robbins, Marta Loyácono, Paul Marsh, Carlos Roberto Brandão and G. Delvare provided the insect identifications. Janie Silva identified the plants. The field work was financially supported by FINEP. Doctoral scholarship came from CAPES.

### Literature Cited

- ATSATT, P. R. 1981. Ant-dependent food plant selection by the mistletoe butterfly *Ogyris amaryllis* (Lycaenidae). *Oecologia* 48: 60-63.
- BALLMER, G. R. and G. F. PRATT. 1989. A survey of the last instar larvae of the Lycaenidae (Lepidoptera) of California. *J. Res. Lepid.* 27: 1-81.
- BROWER, L. P. 1958. Bird predation and food plant specificity in closely related procryptic insect. *Amer. Natur.* 92 (864): 183-187.
- BROWN, R. M. 1969. Larva and habitat of *Callophrys fotis bayensis* (Lycaenidae). *J. Res. Lepid.* 8: 49-50.
- CALLAGHAN, C. J. 1981. Notes on the immature biology of two myrmecophilous Lycaenidae: *Juditha molpe* (Riodininae) and *Panthiades bitias* (Lyceninae). *J. Res. Lepid.* 20 (1): 36-42.
- COTTRELL, C. B. 1984. Aphytophagy in butterflies: its relationship to myrmecophily. *Zool. J. Lin. Soc.* 79: 1-57.
- DEVRIES, P. J. and I. BAKER. 1989. Butterfly exploitation of ant-plant mutualism: adding insult to herbivory. *J. New York Ent. Soc.* 97 (3): 332-340.
- EMMEL, J. F. and C. D. FERRIS. 1972. The biology of *Callophrys (Incisalia) fotis bayensis* (Lycaenidae). *J. Lepid. Soc.* 26: 237-244.
- HENNING, S. F. 1983. Biological groups within the Lycaenidae (Lepidoptera). *J. Ent. Soc. So. Africa* 46 (1): 65-85.
- HINTON, H. E. 1951. Myrmecophilous Lycaenidae and other Lepidoptera - a summary. *Proc. So. London Ent. Nat. Hist. Soc.* 1949-1959, 111-175.
- MALICKY, H. 1970. New aspects on the association between lycaenid larvae (Lycaenidae) and ants (Formicidae, Hymenoptera). *J. Lepid. Soc.* 24: 190-202.
- MASCHWITZ, U., M. SCHROTH, H. HANEL and T. Y. PONG. 1984. Lycaenids parasitizing symbiotic plant-ant partnerships. *Oecologia* 64: 78-80.
- MASCHWITZ, U., M. SCHROTH, H. HANEL and Y. P. THO. 1985. Aspects of the larvae biology of myrmecophylous lycaenids from West Malaysia (Lepidoptera). *Nach. Ent. Ver. Apollo, Frankfurt* 6: 181-200.
- ORSAK, L. and D. W. WHITMAN. 1986. Chromatic polymorphism in *Callophrys mossii bayensis* larvae (Lycaenidae): spectral characterization, short-term color shift, and natural morph frequencies. *J. Res. Lepid.* 25: 188-201.

- PIERCE, N. E. and S. EASTEAL. 1986. The selective advantage of attendant ants for the larvae of lycaenid butterfly, *Glaucopsyche lygdamus*. J. An. Ecol. 55: 451-462.
- PIERCE, N.E. and M. A. ELGAR. 1985. The influence of ants on host plant selection by *Jalmenus evagoras*, a mymecophilous lycaenid butterfly. Behav. Ecol. and Sociob. 16: 209-222.
- PIERCE, N. E. and P. S. MEAD. 1981. Parasitoids as selective agents in the symbiosis between lycaenid butterfly larvae and ants. Science 211 (132): 1185-1187.
- ROBBINS, R. K.\* 1991. Evolution, comparative morphology, and identification of the Eumaeine butterfly genus *Rekoa* Kaye (Lycaenidae: Theclinae). Smithsonian Contributions to Zoology 498: 64.
- ROBBINS, R. K. and A. AIELLO. 1982. Foodplant and oviposition for Panamanian Lycaenidae and Riodinidae. J. Lepid. Soc. 36 (2): 65-75.
- WILSON, A. 1987. Flavonoid pigments in chalkhill blue (*Lysandra coridon* Poda) and other lycaenid butterflies. J. Chem. Ecol. 13 (3): 473-493.